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Innovation in AI-Enabled Interdisciplinary Teaching Modes and Effect Evaluation

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Abstract: Artificial intelligence (AI) technology is profoundly enabling the innovation of interdisciplinary teaching modes through such dimensions as reconstructing knowledge connection paths, optimizing teaching scenario design, and innovating evaluation systems. Based on typical cases at home and abroad, and combining the characteristics of AI technology with educational theories, this study proposes a four-dimensional innovation model of "dynamic generation of knowledge graphs - integration of virtual and real scenarios - adaptation of personalized learning paths - multimodal evaluation and feedback".

Keywords: Artificial intelligence; Interdisciplinary teaching; Mode innovation

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1. Introduction

In recent years, with the rapid development of artificial intelligence (AI) technology, it has profoundly changed the way of education. General Secretary Xi Jinping demanded at the National Education Conference that "we should attach great importance to the challenges brought by AI to education, actively explore the integrated development of AI and education, and promote educational reform and innovation." In terms of interdisciplinary learning, AI technology has subversive value. Interdisciplinary learning has characteristics such as difficult-to-break disciplinary barriers caused by the fragmentation of disciplines, low efficiency of intelligent dynamic integration, and insufficient targeted guidance. AI technology can promote the development of interdisciplinary learning from aspects such as intelligent knowledge graphs and the deep integration of virtual and real intelligent scenarios.

2. Model innovation of interdisciplinary teaching empowered by artificial intelligence

2.1. Dynamic integration model driven by knowledge graph

2.1.1. Intelligent knowledge connection

The semantic association capability of artificial intelligence enables infinite possibilities for semantic relevance.

With the help of artificial intelligence, we can introduce the imaging principle of CT in medical science to students based on the wave-particle duality in quantum mechanics. This allows students to achieve interdisciplinary leaps and connections in knowledge with AI assistance, which can be called a "knowledge point springboard," fostering the expansion of students' horizons as well as their initiative, interest, and curiosity in learning. AI will automatically adjust the jumps in the knowledge graph in real time according to students' learning progress and interest levels, enabling a personalized "learning through play" experience within the graph [1].

2.1.2. Supporting cases

The course "Biosensing Technology" at Nanjing University of Science and Technology has also attempted to use AI to construct a disciplinary knowledge system graph, which automatically summarizes the core knowledge points and theories in the course's knowledge structure. Combined with the requirements of different experiments, AI can design optimal combinations of experimental materials based on relevant theories. With this technology, students can quickly find the nodes connecting different parts of the knowledge structure during the process of building it, at a speed far exceeding that of doing it on their own. This implementation also shows that AI greatly promotes the interweaving and reorganization of knowledge across different fields, and can provide references and inspirations for the reconstruction of interdisciplinary knowledge in other disciplines.

Maastricht University in the Netherlands used an AI-based audit assistance tool called Mind Bridge AI Auditor in its auditing course, simulating an interdisciplinary learning scenario combining accounting and computer science. Students were divided into groups of four, and actual transaction data from a listed company was selected as the experimental dataset. The students were required to input the transaction data into the AI system and complete three main steps: first, using AI machine learning technology to analyze the heterogeneous data in this large-volume transaction and generate a heat map of risk occurrence rates; second, manually conducting risk analysis and designing audit procedures for transactions with high risk occurrence rates to identify transaction fraud patterns; third, adjusting the weight settings of various variables in the machine learning risk model, and reflecting on how different audit procedures affect the analysis results and how to reduce audit risks. This requires students to not only understand the academic principles of audit rules but also have a deeper understanding of the design and implementation of machine learning technologies, such as feature engineering and anomaly detection algorithms in machine learning. Moreover, through the comparison results of 127 groups of experiments, it was found that compared with traditional teaching methods, the accuracy of results (such as identifying the probability of transaction fraud) presented by the AI-assisted algorithmic auditing method increased by 14%, and students independently designed a hybrid auditing model that combines business rules with transaction data characteristics.

2.2. Context construction model of virtual-real integration

With the emergence of VR/AR technology as a branch of artificial intelligence, we are endowed with the means to enable interdisciplinary teaching with panoramic and immersive experiences. For example, in the scene experience of ancient Egyptians building dams, students can put on VR glasses to enter a panoramic immersive teaching environment and see how ancient Egyptians used their wisdom to build dams and carry out irrigation. In the simulated environment of teaching software, through operation, students can truly see how ancient Egyptians built dams, understand the structure of dams, and at the same time, combine practical operations to observe how ancient Egyptians actually carried out irrigation. Through practical operations, they can judge what conditions they need to improve irrigation efficiency. At the same time, the actual behavior data of students' operations and

the behavior data during the learning process are statistically analyzed and summarized by intelligent algorithms. Thus, students' cognitive difficulties and interest can be known. According to students' needs, the algorithm then upgrades their abilities to help them break through cognitive difficulties and develop the transfer ability and innovation ability of interdisciplinary learning [2].

2.3. Data-driven personalized learning paths

Intelligent learning oriented to students' learning situation uses AI technology to establish a personalized learning partner relationship of cognitive insight, accurate diagnosis, and intelligent guidance through big data analysis and machine learning models. It collects and analyzes data on knowledge mastery, cognitive development, and learning behavior habits from multiple dimensions, establishes learning portraits based on knowledge graph data, and adaptively establishes personalized learning paths for students with thousands of faces through feature aggregation and association rule mining of machine learning. It establishes intelligent learning resource matching, learning rhythm control, and the key in the process is to find the most effective learning path. In terms of technical implementation, the knowledge space model is used to determine the zone of proximal development for learning, the Bayesian knowledge tracing to predict the learning state, and the multi-armed bandit model to optimize the learning path, specifically the personalized learning path composed of knowledge sequence, resource type, interaction mode, etc. [3]

For example, adaptive learning uses big data and machine learning algorithms to analyze students' learning behavior data, including learning time, accuracy of answering questions, learning progress, etc., to deeply understand each student's learning characteristics and needs. Integrating adaptive learning into the classroom is highly targeted and follows the principle of adapting to students' needs. Taking a primary school classroom in Suzhou, Jiangsu Province as an example, AI digital humans are used as teachers in the classroom. They not only dynamically adjust the teaching rhythm by feeding back students' pronunciation accuracy and grammar application level, but also appropriately adjust the learning rhythm in real-time according to students' learning situation and preferences. For instance, in a class, the AI digital human teacher finds that individual students have a high accuracy in pronouncing words when reading English, but their pronunciation of some letters is still not accurate enough. Immediately, the digital human teacher identifies the accurate pronunciation of these letters, and students correct their pronunciation by following the reading. The digital human teacher also matches animation effects on the screen to help students solve pronunciation problems as soon as possible in an interesting way. The application of artificial intelligence in teachers' "teaching" and students' "learning" allows students to learn according to their own level, and reasonably sets the learning progress in the dynamic evaluation of "teaching" and "learning," so that each student can receive the most suitable teaching content and rhythm, and feel their own learning progress and rhythm. This is the real "thousands of people, thousands of faces." This new learning method greatly stimulates students' interest and improves their efficiency, and also has certain reference significance for other aspects of students' learning [4].

2.4. Multimodal evaluation and feedback system

2.4.1. Innovation heat map

Shandong University of Art & Design has introduced an AI evaluation system, which can not only comprehensively assess students' interdisciplinary works from 12 dimensions, including aesthetics, technical rationality, and creativity, but also automatically generate an intuitive and visualized innovation heat map through AI algorithms. Different colors and lightness indicate the level distribution of students in each dimension,

enabling teachers to intuitively perceive students' innovation ability and strong fields. In addition, the AI system can also provide students with targeted suggestions for improvement, point out the directions they can work on, and stimulate their motivation for continuous creation. The application of the innovation evaluation system provides new tools and methods for interdisciplinary teaching evaluation [5].

2.4.2. Ethical annotation mechanism

Second, in terms of the ethical annotation mechanism, as AI technology is increasingly applied in interdisciplinary teaching, it is urgent to implement an ethical annotation mechanism in terms of academic integrity and originality of works. For example, the EU stipulates that work with more than 50% AI intervention must be marked with "technology-assisted". On the one hand, this can alert evaluators and readers to pay attention to the creation process of works, thereby forming academic recognition and respect for AI-assisted creative works; on the other hand, it can also help us more clearly indicate the participation and proportion of humans in creation, making AI-assisted creation more conducive to interdisciplinary teaching and the development of AI technology.

3. A multi-dimensional evaluation system for the empowering effects of artificial intelligence

3.1. Improvement in academic performance

In higher vocational education and undergraduate education, artificial intelligence (AI) technology enables precise diagnosis of learning needs and personalized teaching, thereby enhancing students' professional practical abilities and capabilities in solving complex problems. For example, the School of Electronic Information and Artificial Intelligence at Shaanxi University of Science and Technology has explored educational innovation by integrating AI technology. In their research on the "AI-empowered hybrid teaching model combining theoretical and experimental tracks (online and offline)," AI teaching assistants construct intelligent training modules for integrated circuit design, AI algorithms, and other subjects through knowledge graphs. By collecting real-time process data such as students' programming, debugging and experimental operations, it was found that compared with traditional teaching models, the code error rate of vocational students in embedded system development decreased, and the completion rate of projects improved [6].

3.2. Innovation capability and critical thinking

Beyond STEM literacy, the effective integration of AI technology also positively promotes students' creativity and critical thinking. Studies have shown that AI integration enhances students' innovative and creative abilities [7]. Specifically, ANOVA tests indicate that after AI integration, students completing interdisciplinary tasks demonstrated approximately a 27% improvement in creative performance, with a statistically significant difference ($p < 0.05$). This is mainly because AI integration significantly increases students' vicarious experiences—such as virtual science, virtual laboratories, and virtual environments—providing them with more experiences to foster innovation and creativity.

Furthermore, AI as a source of vicarious experience effectively enhances students' confidence in creation. Regression analysis reveals a significant positive correlation between AI-based vicarious experiences and students' creative confidence ($\beta = 0.37$), meaning more vicarious experiences provided by AI correspond to higher creative confidence. This is a fundamental attitude and ability for students' future interdisciplinary exploration and innovation.

3.3. Development of interdisciplinary literacy

AI technology, in conjunction with UNESCO's 5C model (critical thinking, creativity, communication, collaboration, and culture preservation), strongly supports the development of interdisciplinary literacy. In other words, through intelligent learning resources and interactive platforms, AI promotes the development of students' interdisciplinary competencies, including critical thinking, creativity, communication, collaboration, and cultural preservation [8].

(1) Critical Thinking: AI can automatically provide learning materials and questions tailored to students' cognitive abilities and learning progress, encouraging them to engage in independent analysis and reasoning. Additionally, AI offers one-on-one feedback, fostering rational and independent thinking.

(2) Creativity: AI not only provides students with a wealth of innovative ideas (e.g., AI-generated design schemes, simulated experimental data) but also offers new creative insights and optimizes ideas through data analysis. This intelligent support significantly boosts students' enthusiasm for innovation and the quality of their ideas [9].

(3) Communication: Through speech recognition and natural language processing, AI enables smooth human-machine dialogue. Students can express their viewpoints and ideas to AI, receive instant responses and suggestions, and this intelligent interaction enhances their communication skills while promoting deeper integration between students and AI in the learning process.

(4) Collaboration: AI introduces new forms of cooperation, such as virtual teams and online collaboration, providing students with opportunities for cross-temporal and cross-spatial collaborative learning. In collaborative tasks, students work with peers from diverse backgrounds to solve problems, create value, and integrate resources. This intelligent collaboration generates an invisible momentum that draws students into interactive engagement, fostering teamwork skills, interdisciplinary knowledge exchange, and innovation [10].

(5) Cultural Preservation: AI converts traditional cultural resources into accessible, transmissible forms through digitization and virtualization. Students can learn about traditional culture, appreciate traditional art, and participate in cultural activities via AI, deepening their understanding and identification with heritage. This intelligent expansion strengthens the inheritance of traditional culture.

3.4. Optimization of teaching efficiency

Fourth, teachers' digital literacy influences teaching efficiency: the higher their digital literacy, the better they can leverage AI to optimize lesson planning and execute teaching tasks in the classroom [11]. On one hand, teachers with strong digital literacy can flexibly apply AI to design targeted, effective teaching activities based on actual needs and students' learning status. On the other hand, they can fully utilize AI's real-time feedback and big data analysis functions to accurately assess student performance, provide personalized support, and ultimately improve teaching quality and efficiency.

4. Challenges and countermeasures: Balancing technological empowerment and educational essence

4.1. Degree of academic performance improvement

4.1.1. Risk characteristics

After interdisciplinary teaching adopts standardized templates, teaching efficiency has been improved, but it will

also lead to homogeneity in students' homework. In the process of students' creation, the teaching content and learning suggestions output by AI, together with the mode of cooperation with AI, follow templates and program algorithms. This mode is convenient but will invisibly restrict students' creativity and uniqueness. In the long run, it is easy to form students' thinking stereotypes. Maintaining innovation and uniqueness may make students lose the ability to solve problems independently.

4.1.2. Coping strategies

To prevent students' works from being identical when using AI for creation, teachers should guide students to use AI technology correctly while leaving a certain original space and encouraging diversity. They can design some open-ended questions and provide different learning materials to promote students' creative divergence and personalized performance. The AI system itself should also constantly improve its algorithms, reduce the set templates for students, and provide more diversified suggestions and feedback.

4.2. Dilemma in the transformation of teachers' roles

When facing difficulties in promoting the transformation of teachers' roles, schools and teachers themselves need to actively respond. Schools should regularly hold teacher training courses, workshops, etc., to help teachers transform from traditional "knowledge lecturers" to "AI collaborators." The training content should not only include common sense and application of AI technology, but also discuss how to use AI technology to carry out innovative practical activities in interdisciplinary education.

The transformation should not stay at the verbal level. As teachers, they should take the initiative to accept this transformation, earnestly learn and understand knowledge about artificial intelligence technology and interdisciplinary teaching. Based on Venkatesh's Technology Acceptance Model, they can improve their ability to operate intelligent tools and their interdisciplinary learning and development capabilities from multiple perspectives, such as perceived usefulness, perceived ease of use, and social influence. They should take the initiative to accept new teaching methods and technologies, reflect on and adjust their teaching behaviors to adapt to the needs of the times [12].

Schools and teachers also need to carry out cooperation and exchanges to jointly explore the optimal application scheme of AI technology in interdisciplinary learning. For example, organize interdisciplinary teaching forums, gather teachers from different disciplines to share their teaching experience and insights in interdisciplinary learning, and promote the exchange and collision of knowledge between different disciplines; establish an AI education and teaching case database, collect some successful AI education and teaching cases, and share them with other teachers.

Through the above attempts, it is believed that teachers can successfully overcome the hurdle of role transformation, complete the transformation to the role of collaborative designers of AI technology and disciplines, and contribute to the all-around development and cultivation of students' innovative ability.

4.3. Resource integration and policy coordination

Integrate resources and coordinate policies to create a good educational ecology. First, explore and develop a series of innovative and practical interdisciplinary courses like "AI + X" as done by the High School Affiliated to Renmin University of China. This aims to solve problems such as students' excessive "verticalization" in knowledge fields, rigid vision, and diminished learning interest, to promote students to understand and experience AI through the integration and intersection of various disciplines, and on this basis, stimulate

students' exploration of the internal connections between different fields. Second, strengthen in-depth industry-university-research cooperation with enterprises, introduce the latest AI and application scenarios, and connect the theoretical and practical aspects of courses [13].

The "education consortium" model is also a way to achieve in-depth coupling of school-enterprise resources. For example, organizing various organizational structures such as schools, enterprises, and research institutions to establish education consortia can, on the one hand, share resources, carry out collaborative innovation, and jointly explore the development of AI technology in interdisciplinary teaching practice models; on the other hand, promote close links between industry, university, research, and application, providing strong support for cultivating innovative and practical talents.

In the process of resource integration and policy coordination, the following two points should also be noted: first, pay attention to the effective integration and reasonable adaptation of resources to prevent redundant construction and resource waste; second, strengthen policy guidance and support to provide relatively perfect institutional guarantees and policy support for the development of interdisciplinary teaching under AI technology; third, innovate the evaluation system, establish an evaluation system that can comprehensively reflect learners' interdisciplinary learning and the improvement of interdisciplinary learning ability, and support learners to actively participate in interdisciplinary learning and practical actions, to promote the in-depth development of learners' interdisciplinary learning [14,15].

5. Conclusion

In conclusion, the introduction of new forms of AI in interdisciplinary teaching has brought about a new transformation in teaching forms and a new multi-dimensional evaluation system, bringing new developments to students' learning, innovation, and evaluation, enabling students' interdisciplinary literacy to be fully developed and improved, and playing a role in teaching optimization. However, we must also face up to the problem of balancing technological empowerment and educational essence in the era of artificial intelligence, and build a three-dimensional educational ecology.

Disclosure statement

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